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HONEYCOMB STRUCTURE AND DEVICE FOR PRODUCING SAME

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[Wabenstruktur und Vorrichtung zu deren Herstellung]

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The present invention concerns a honeycomb structure with several film strips connected to each other and arranged one on top of the other. It also concerns a device for producing such a honeycomb structure.

Previously described honeycomb structures with the features according to the class have been produced especially out of transparent films. Such transparent honeycomb structures are typically designated as transparent heat insulation (TWD) and are used everywhere that high heat

insulating values are required in connection with high visual transparency, like, e.g., façade arrangements with transparent heat insulation, glazing for solar collectors, and also glazing for factory buildings, greenhouses, gymnasiums, etc.

In practice, up until now TWD structures for the example applications mentioned above have been produced industrially with the help of extrusion processes. Here, thin-walled plastic tubes with diameters of ca. 3.5 mm or alternatively ca. 15 mm tall profiles with honeycomb-shaped structure are extruded, bundled together in a second processing step, and cut with a heating wire to the desired insulating thickness, wherein the tubes or the profiles are adhered together at the side surfaces by means of the cutting process. This produces box-like, free-standing capillary structures. The extrusion process for generating such a capillary structure requires a small capillary diameter and a relatively thick wall thickness of ca. 30 μm to generate a stable structure. These conditions produce a relatively high material consumption and in connection to this fact, a high weight for such capillary structures. It is also disadvantageous that the transparency is limited, especially for diffuse or direct light that is incident at an angle. In addition, one disadvantageous effect is that reflections can occur at the cut edge, because these edges are often unclean due to the cutting process.

In addition to structures for transparent heat insulation, as have been described above, in recent times structures have become known, for which thin-walled glass tubes are arranged between two glass disks spaced apart from each other perpendicular to the disks, so that an insulating structure is produced between the glass disks. Such structures consisting of glass capillaries are very resistant to temperature and weather, but expensive in terms of production and also have a high weight, which has a disadvantageous effect, especially for the use of solar collectors.

In addition, there is the possibility of producing honeycomb structures for transparent heat insulation, where individual film strips are welded layer by layer between very thin spacer combs, which are used for separating the films. Here, the welding process is configured so that two films lying one on top of the other are connected to each other offset relative to each other. The actual honeycomb structure with diamond-shaped cells is produced only when the welded film stack is pulled apart at its ends to form the diamond-shaped structure. The thickness of the structure is produced from the width of the film strips and the height from the number of film strips arranged one on top of the other. For tensioning such structures, a suitable mount with a frame made of, e.g., wood or metal, in which the honeycomb structure can be suspended, is necessary.

The production process for such diamond-shaped honeycomb structures is complicated, wherein there is also the problem of bringing the films that are connected to each other and that

are stacked one on top of the other into a three-dimensional shape by means of a suitable mount. This process can be automated only with difficulty.

Therefore, the task of the present invention is to create a honeycomb structure and also a device for producing such a structure, which overcomes the disadvantages of existing structures, which consequently exhibits a three-dimensional expansion without additional means and retains this expansion independently, which can be produced cost-effectively and simply, and which has decisive weight advantages relative to conventional structures.

This task is solved in connection with the features of the preamble according to the invention by the technical teaching given in the characterizing portion of Claim 1. Here, the film strips are given a U-shaped cross section of horizontal and vertical parts arranged at right angles to each other and the film strips are connected to each other in transition regions by horizontal and vertical parts of the strips arranged one on top of the other. This configuration according to the invention produces a stable honeycomb structure, which is independently free-standing without additional means and for which the force of the structure's own weight is transferred downwards through the vertical crosspieces arranged one on top of the other according to the invention to the support surface. In addition, honeycomb structures with specially adapted heat insulation properties can be produced, in which the distance of the horizontal or vertical parts of the U-shaped, wave-like configuration of the film strips arranged one on top of the other is varied correspondingly. The closer the distances are kept, the better the insulating properties of the entire structure.

Additional special configuration features of the object of the invention result from the features of the subordinate Claims 2-4.

If the honeycomb structures according to the invention are used, especially for the transparent heat insulation mentioned above, then the film strips are advantageously produced from transparent material. The connection between the individual, wave-like film strips can be realized through a welding process or through adhesion of the materials.

In Claim 5, a device according to the invention is disclosed, with which a free-standing honeycomb structure according to the invention with the features of Claim 1 can be produced through a welding process. The device has a welding head with several projections, which are at a distance from each other, which are bounded by vertical and horizontal walls, and for which at least one heating wire is arranged in the transition regions of the vertical and horizontal walls. In addition, the device has a comb-like welding anvil consisting of a connection bridge and counter support fingers projecting into the horizontal cross-sectional plane of the connection bridge, wherein the welding anvil can move in the horizontal direction and the welding head can move in the vertical direction.

With the help of this device, for one thing, the necessary U-shaped wave shape of the film strips can be generated. Simultaneously, a weld for connecting the film strips can be produced with the device at the connection points in the transition region of the horizontal and vertical parts of the correspondingly shaped film structure. With the device according to the invention, in particular very thin films can also be connected to each other, which in turn produces the advantage of high transparency and low material costs for the resulting honeycomb structure. With the invention, not only transparent films, but all types of film material can be connected to each other. One unique prerequisite is the ability of the material to be welded.

Particularly advantageous configurations of the device according to the invention result from the features of the subordinate device claims.

It has proven especially advantageous to coat the counter support fingers of the welding anvil with a high temperature-resistant material, preferably Teflon, so that the welding is performed on a soft, pliable base.

In addition, it is advantageous to form the counter support fingers in their width slightly greater than the opposite free spaces between the projections of the welding head during the welding process. This measure guarantees that even for a slight offset between the free spaces and the counter support fingers of the welding anvil, a sufficient contact or pressure surface is produced for the welding process of the film strips arranged one on top of the other.

One advantageous configuration of the device according to the invention also pre-tensions the heating wires, which are arranged in the edge regions of the projections of the welding head. This can be realized, e.g., by a tensioning device arranged at the side of the welding head. The pre-tensioning has the advantage that it absorbs the elongation produced by the heating of the welding wires so that the position of the welding wires, particularly in the edge region of the projections, where the welding of the film strips arranged one on top of the other takes place, remains correct at all times.

In order to bring the film strips to be welded together into the required U-shaped wave configuration in a simple way, it has proven to be advantageous to arrange suction devices between the projections of the welding head, i.e., at the base of the grooves formed by the projections. These suction devices preferably have at least two suction nozzles, which are arranged at each groove base and which are connected in turn to a low-pressure suction line. The suction device has the advantage that the wave-shaped structure of the film strips can be maintained without additional mechanical means, which also simplifies the automation of the entire production process and thus makes the production of the free-standing honeycomb structure simpler and more cost-effective.

In the following, the honeycomb structure according to the invention and also a device for producing this honeycomb structure is explained in more detail with reference to the attached drawings. Shown are:

Figure 1, a honeycomb structure according to the invention in a side view,

Figure 2, side view of a device for producing the honeycomb structure from Figure 1,

Figure 3, top view corresponding to the label A/A in Figure 2 of the device according to the invention from Figure 2.

The honeycomb structure according to the invention shown in Figure 1 has several wave-like film strips 1 arranged one on top of the other. The wave shape of the film strip 1 is configured so that each film strip has alternating open U-shaped regions with horizontal parts 3 and vertical parts 4. The film strips typically have a range of depths in the direction vertical to the plane of the drawing from 3 to 12 cm. This depth dimension is dependent on the desired heat insulation capability of the entire honeycomb structure. The heat insulation capability can also be varied such that the vertical parts 4 and the horizontal parts 3 are shaped differently in size. A reduction of the parts 3 and 4 creates a fine-meshed honeycomb structure, which leads to an increase of the insulating capacity of the latter.

The honeycomb structure according to the invention maintains transition or corner regions 5 between the vertical parts 4 and the horizontal parts 3 of the film strips through the U-shaped structure. The film strips 1 arranged one on top of the other are connected to each other at these transition regions 5 by welds 7, which are indicated as points in the drawing for reasons of simplicity and which connect the individual film strips to each other along their entire depth vertical to the plane of the drawing. A honeycomb structure is produced, which automatically assumes and maintains a three-dimensional shape without additional aids, such as frame constructions, mounts, or the like. Such a honeycomb structure can be produced in arbitrary sizes, i.e., it is only dependent on the width and length of the film strips, and then used without a problem, e.g., for the purpose of the heat-insulating structures mentioned above. The field of application of such honeycomb structures according to the invention, particularly for the use of transparent film strips, is the production of transparent heat insulation (TWD), as used, e.g., for solar collectors or for the insulation of greenhouses.

The connection of the individual film strips 1 at the points designated with 7 is possible through adhesion or through the creation of welds running perpendicular to the film strip, as already described above.

In the following, a device, which can help to produce a honeycomb structure according to the invention by using weld connections between the individual film strips, is described as an example.

Figure 2 shows a honeycomb structure 10 corresponding to Figure 1, which is expanded in height through deposition of additional film strips and welding them with the already present honeycomb structure. The device, designated as a whole with 20, for producing the honeycomb structure 10 has a welding head 22 that can move in the direction of the arrow 30 in the vertical direction. The welding head consists of a traverse 23 and several projections 24 arranged on the side facing the honeycomb structure. The projections 24 have an essentially square cross section with vertical walls 25 and horizontal walls 26. In the edge regions 27 at the transition between vertical and horizontal walls 25 and 26, respectively, of the projections 24, heating wires 31 extend at the free ends projecting along the entire edge of the projection 24 vertical to the plane of the drawing. The heating wires 31 are guided upwards at the sides of the welding head and are led by a suspension device to the adjacent edge region.

The suspension device is configured as a tensioning device. Tension springs 36 alongside the welding head expose the heat wires to pre-tensioning and equal elongation of the heating wires, e.g., due to heating. The helical springs shown schematically in Figure 2 have proven to be especially cost-effective and practical variants.

During the welding process, a welding anvil 32 is located underneath the welding head 22. The welding anvil consists of a connection bridge 33 and counter support fingers 34 arranged at the side in the horizontal cross-sectional plane of the connection bridge.

During the welding process, the counter support fingers 34 are each arranged opposite a gap produced between the adjacent projections 24. The width of the counter support fingers 34 is slightly larger than that of the gaps between the projections 24, so that even for slight displacement of the counter support fingers 34, a sufficient contact surface for the heating wires 31 of the welding head arranged in the edge region 27 is realized for all cases. In addition, the edges of the counter support fingers 34 are slightly angled, so that an especially good contact for the heating wires 31 is produced. The welding anvil can move in the horizontal direction, i.e., vertical to the plane of the drawing in the direction of the arrow 35.

For performing an individual welding process, the welding head is first brought into a raised position. Then a film strip to be welded is laid in the welding head so that the film strip 1 assumes the wave-like shape shown in Figure 2. The deposition process is supported such that suction nozzles 40 are arranged in the intermediate spaces 29 between the projections 24. These suction nozzles are connected in turn to a low-pressure suction line and the film strips brought into position in the intermediate spaces 29 underneath the welding head are drawn in until they contact the suction nozzles.

Simultaneously, the anvil with its counter support fingers 34 moves from the side into the upright chambers of the last welded film strip of the honeycomb structure 10. When the counter support fingers 34 have completely moved into the chambers of the uppermost film strip of the

honeycomb structure 10, the welding head 22 sinks to the welding anvil 32. Through this downward motion, the film strip laid in the welding head contacts the film strip, into which the counter support fingers of the welding anvil have moved. Simultaneously, the edge regions 27 with the heating wires 31 arranged there contact the counter support fingers and press the two intervening film strips together.

During or after the downward motion of the welding head 22, the heating wires 31 are heated for a short period, so that when the welding head contacts the welding anvil, the welding temperature necessary for connecting the film strips has been reached. After a short period of pressure on the film strips, the suction nozzles 40 are switched off in the intermediate spaces 29 and the welding head returns to the raised position. The welding anvil simultaneously moves to the side, out of the honeycomb structure 10 and then the newly created film strip is replaced in the intermediate spaces through lateral shifting. Simultaneously, in the raised position of the welding head, a new film strip is drawn in by the suction nozzles 40 into the intermediate space 29 between the projections 24 of the welding head. Then the welding process for the next film strip can be performed according to the means and method already described above.

It has proven to be especially practical to arrange several suction nozzles 40 distributed across the width of the welding head 22 within the groove base of the intermediate spaces 29. This method guarantees a uniform drawing-in process of the film strip to be welded in the intermediate space 29. It can be clearly seen in Figure 3 that for the illustrated width of the welding head 22, e.g., 2 suction nozzles 40 have proven to be sufficient.

In addition, it has proven to be advantageous to coat the counter support fingers 34 of the welding anvil 32 with a thin, pliable layer made of a high temperature-resistant material, preferably Teflon. This layer prevents adhesion. In addition, the welding takes place on a soft base, which improves the quality of the resulting weld.

List of reference symbols

1	Film strip
3	Horizontal part
4	Vertical part
5	Transition region
7	Weld
10	Honeycomb structure
20	Device
22	Welding head
23	Traverse
24	Projection

25 Vertical wall
26 Horizontal wall
27 Edge region
29 Intermediate space
30 Arrow
31 Heating wire
32 Welding anvil
33 Connection bridge
34 Counter support finger
35 Arrow
36 Tension spring
40 Suction nozzle

Claims

1. Honeycomb structure with several film strips arranged one on top of the other and connected to each other, characterized in that the film strips (1) have a wave shape with U-shaped cross section of horizontal and vertical parts (3, 4) arranged essentially at right angles to each other and that the film strips (1) are connected to each other in the transition region (5) by horizontal and vertical parts (3, 4) of the film strips (1) arranged one on top of the other.

2. Honeycomb structure according to Claim 1, characterized in that the film strips (1) are produced from a transparent material.

3. Honeycomb structure according to Claim 1 or 2, characterized in that the film strips are welded to each other.

4. Honeycomb structure according to Claim 1 or 2, characterized in that the film strips (1) are adhered to each other.

5. Device for producing a honeycomb structure according to one of Claims 1-3, characterized in that it has a welding head (22) with several projections (24) spaced apart from each other and bounded by vertical and horizontal walls (25, 26), for which at least one heating wire (31) is arranged in the edge region (27) of each vertical and horizontal wall (25, 26), and a comb-like anvil consisting of a connection bridge (33) and counter support fingers (34) projecting into the horizontal cross-section plane of the connection bridge (33), wherein the welding anvil (32) can move in the horizontal direction and the welding head (22) can move in the vertical direction.

6. Device according to Claim 5, characterized in that the counter support fingers (34) of the welding anvil (32) are coated with a high temperature-resistant material, preferably Teflon.

7. Device according to one of Claims 5 or 6, characterized in that the counter support fingers (34) are slightly greater in width than the opposing intermediate spaces (29) located between the projections (24) of the welding head (22) during the welding process.

8. Device according to one of Claims 5-7, characterized in that the heating wires (31) are held in the region of the projections (24) of the welding head (22) by at least one tensioning device.

9. Device according to one of Claims 5-8, characterized in that at least one suction device is arranged in the intermediate spaces (29) between the projections (24) of the welding head (22).

10. Device according to Claim 9, characterized in that the suction device has at least one suction nozzle (40) arranged between the projections (24) and this suction nozzle can be connected to a low-pressure suction line.

11. Device according to Claim 8, characterized in that the tensioning device has several tension spring elements preferably configured as helical springs.

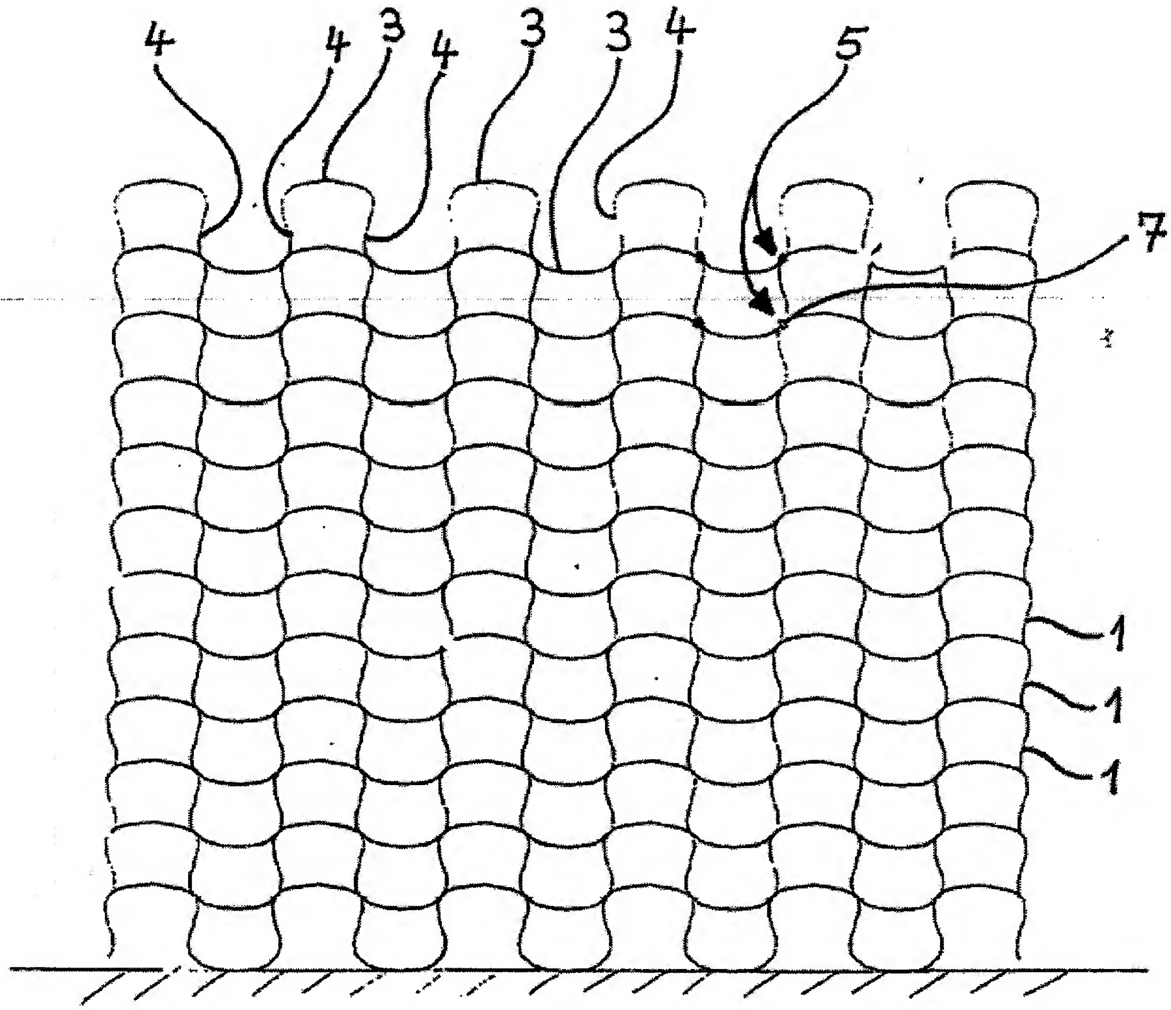

Figure 1

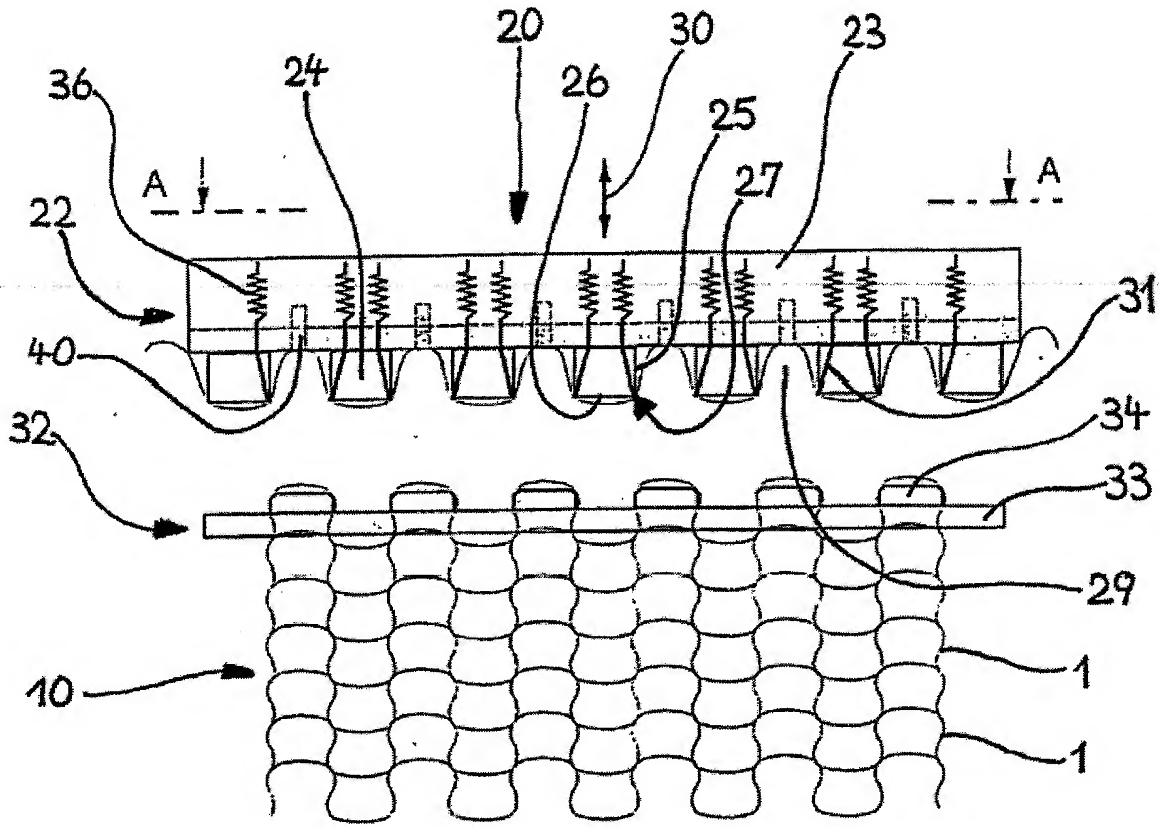

Figure 2

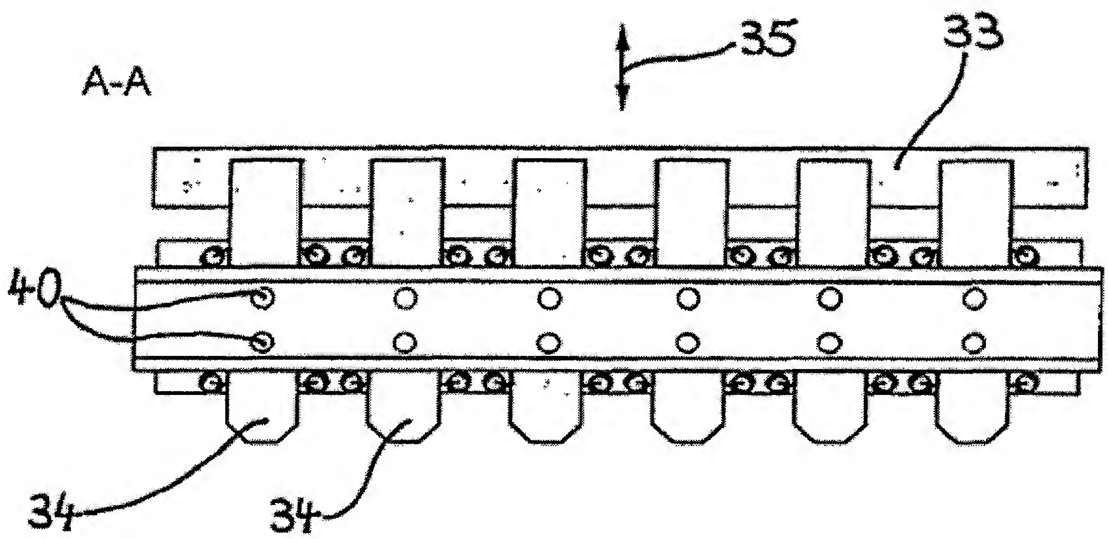

Figure 3